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CHARACTERISTICS OF A WEATHERED ASBESTOS SHINGLE FROM AN OLD OTTAWA BUILDING

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Corrosion of Asbestos-Cement Pipe

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ABSTRACT

Samples from an old asbestos-cement shingle roof were investigated by optical microscopic, X-ray diffraction, spectrographic, and linear measurement techniques. The results indicate that the chrysotile asbestos-cement matrix has weathered the long exposure well. It has corroded only locally, with a maximum loss in thickness of about 16%. In places of strongest erosion, the green top layer has been removed and the coloured surface aggregate particles have been partially dislodged or discoloured. Chromium, sodium and bismuth concentrations are substantially greater on the surface than in the centre of the original shingle. This indicates that the green colour originates from chromium and that water glass has possibly been used for surface treatment.

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B. Nebesar* and J.A. Soles*

Two specimens of asbestos shingle from the dairy barn at the Experimental Farm in Ottawa were received from A. Kozlowski, restoration architect for Public Works Canada. The shingles were reported to be breaking free of the roof of the building. Before undertaking replacement or restoration work, the Department wished to know the state of deterioration of the shingles and their life expectancy, in order to determine whether or not they should continue to be used.

TEST PROCEDURES

The shingles provided were examined under the microscope to determine the primary composition, degree of weathering, products and the apparent weathering agents. Identification of phases was facilitated by study of thin sections and X-ray diffraction (XRD) spectra. Samples of an unweathered section of the green-stained surface layer and of an inside section of the shingle were analyzed spectrochemically. Thickness was measured with a vernier height gauge having a sensitivity of ± 12.5 µm

RESULTS

Weathering Effects

Stereomicroscope examination revealed that the shingle is an asbestos-cement type. The cement paste contains fine aggregate particles of quartz, feldspar and other rock materials; bundles and fibres of

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chrysotile asbestos, confirmed by XRD analysis, serve as the strengthening phase. It appears that during manufacture the external (ribbed) surface was impregnated with either green or blue dye, followed by impressing a thin, uneven layer of fine, red-coated aggregate into the stained surface. The features are shown in Fig. 1.

The degree of weathering of the shingle varied according to its exposure. The upper sections of shingles, covered by overlying shingles are completely fresh and unweathered. Strips in the narrow (40-50 mm) moisture flux zone under the lower edge of an overlying shingle have lost much of the red coloration from the coating on the abrasion-resistant aggregate, but the green-dyed concrete paste has leached little. Where a shingle was fully exposed, however, leaching was relatively intense; most of the protective aggregate has been dislodged and much of the green-dyed paste layer corroded, leaving only scattered areas that had been deeply impregnated. The eroded surface is coated with exposed ends of asbestos fibres, larger particles of aggregate and lichen.

The most deeply weathered section of a shingle was along the bottom 30 mm of an exposed surface. To obtain information on the maximum rate of erosion, measurements of the shingle thickness in that zone at both groove and ridge sites were compared with measurements of the corresponding thicknesses of the unweathered shingle.

From the results shown in Table 1, the following can be deduced:

(a) Measurements were reproducible within the precision shown.

(b) They are also reproducible from sample to sample. (Insufficient test material was available for full testing according to ASTM specification for asbestos-cement roofing shingles.)

(c) The difference in thickness between the weathered and unweathered sites is much larger than the precision of measurement, i.e. the results have a true physical meaning.

(d) The thickness of the shingle tested was reduced by a maximum of about 16% at sites of the deepest corrosion.

(e) Most of the exposed surface area is much less corroded than the sites measured. Specimens from other parts of the roof, by surficial observation did not appear significantly different.

Spectrochemical Analysis

Two samples were analysed by semiquantitative optical emission spectrographic analysis: an unweathered green-dyed surface section of paste layer and an inside section of shingle apparently free of the green dye. Table 2 shows the concentrations of the only three elements out of 36 tested that differed significantly:

Chromium is abundant in the green layer. It was probably the ion, or oxide, used to obtain the green colour.

Sodium content is higher in the green layer than in the grey one. A sodium silicate (water glass) sealer may have been used.

Bismuth is also more abundant in the green layer, for a reason unknown.

CONCLUSIONS

The results of this investigation indicate that these shingles have weathered well over their period of exposure. Furthermore, from discussion with specialists in the production of asbestos cement products and consultation with relevant technical literature it appears that the matrix of shingles has stood the test of time very well.

The surface erosion does not by itself represent a serious reduction in the serviceability of the shingles. Unless there is an increase in corrosion rate, they could withstand an equal period of weathering.

Consequently, we suggest that they be left alone except for routine maintenance such as required replacement. Cleaning with muriatic acid is not recommended, nor is harsh cleaning and scrubbing; all such drastic measures may do more harm than good. If a coating should be demanded, prior light scraping of lichen may help to smooth the surface, but the potential durability of the impregnant should be known.

The most critical point is the fasteners, which will determine the long-term serviceability of the roof. The type used was the

ordinary galvanized nail with a narrow tapered head; it resisted corrosion well, but apparently the head works through the hole easily, releasing the shingle. A thin flat head may serve longer.

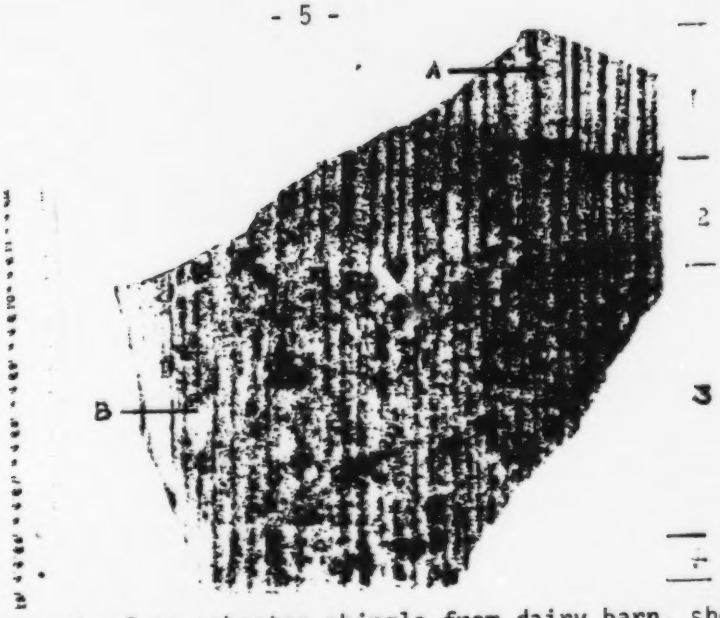

FIGURE 1. Photograph of an asbestos shingle from dairy barn, showing the degrees of weathering with different exposure.

1. unweathered, in completely protected zone beneath a shingle;
2. leached of colour, in wet zone beneath overlying shingle;
3. exposed; protecting aggregate and green layer leached and corroding, lichen (dark grey) attached;
4. most deeply eroded section; green layer mostly removed.

Note that molding ridges remain intact to the lowest edge.

Spectrographic samples and thin sections taken near location A,B

FIGURE 2. Petrographic thin sections of an asbestos shingle, the upper one from a more eroded area. The green surface layer is outlined; note that it is of even thickness, and that aggregate particles continue through it to the edge, indicating that it is an impregnated dye. The layer has been depressed (↖) where loose, coloured aggregate particles (P) were pressed into the surface of shingle. Magnification 19X.

TABLE 1. Reduction of Shingle Thickness by Weathering

LOCATION	TREATMENT	NUMBER OF MEASUREMENTS	PRECISION ± %	THICKNESS mm
In Grooves, Large Piece	Original, Protected	8	4.6	3.56
In Grooves, Small Piece	Original, Protected	4	6.6	3.63
In Grooves, Large Piece	Weathered, Exposed	8	3.8	2.97
On Ridges, Large Piece	Original, Protected	8	2.3	4.09*

* A 5/32-in. shingle would be 3.97 mm thick.

TABLE 2. Spectrographic Analyses of Asbestos/Cement Shingle

SAMPLE	ELEMENT CONCENTRATION %		
	Cr	Na	Bi
Greenish Surface Matter	0.21	PC	0.07
Grey Inside Matter	0.12	0.11	ND< 0.001

ND = not detected
PC = principal constituent

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